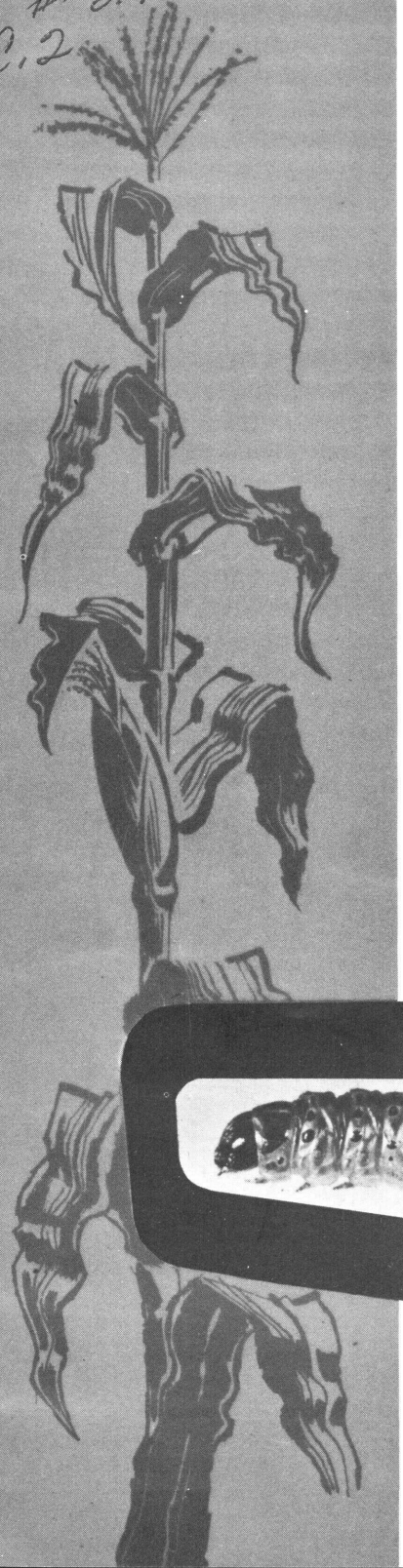
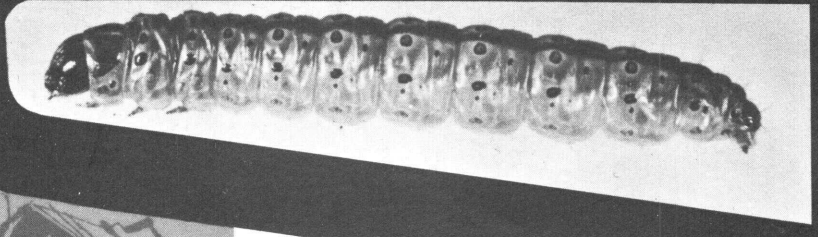
Farmers' Bulletin No. 2190





# *The* European Corn Borer

## *how to control it*



U.S. DEPARTMENT OF AGRICULTURE

## CONTENTS



Front cover photograph (inset picture): Full-grown larva of European corn borer. (Enlarged.) Negative number BN–15612.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Agricultural Research Service




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# *The* EUROPEAN CORN BORER . . . *how to control it*

The European corn borer [1] is one of the most destructive pests of corn. From 1950 to 1965 it caused an average annual loss of more than 96 million bushels of field corn alone. Since it was discovered in Massachusetts in 1917, it has spread westward and southward over a large part of the important corn acreage east of the Rocky Mountains (fig. 1).

This pest attacks all types of corn. It also infests some of the common weeds and grasses that grow in or near cornfields, such as pigweed, smartweed, cocklebur, barnyard grass, lambsquarters, foxtail, and panic grass. It attacks crops such as sorghums, soybean, millet, buckwheat, oats, potato, and pepper, and the flower plants dahlia, cosmos, aster, gladiolus, chrysanthemum, zinnia, and hollyhock. More than 200 kinds of plants have been found infested, although many of them serve as shelter for the insect rather than as food.

## DESCRIPTION AND HABITS

The European corn borer has four stages in its life cycle—egg, larva, pupa, and adult.

The number of annual broods of the corn borer varies with latitude, but may be influenced by weather. Except in northern areas, where only one brood usually occurs, a large part of the borer population is of two broods. In southern areas, more than two broods may develop annually.

This insect passes the winter as a full-grown larva inside its tunnel in the stalk, stubble, or ear of corn, in weeds, or in other plant material where it has found shelter. At this time, the larva is almost 1 inch long and ⅛ inch in diameter (see inset photograph on front cover). The head is dark brown or black. The upper part of the body is gray to light brown or pink, and has rows of brown spots and several brown or pink lines extending lengthwise. The underside of the body is cream colored and has no markings.

[1] *Ostrinia nubilalis* (Hübner).

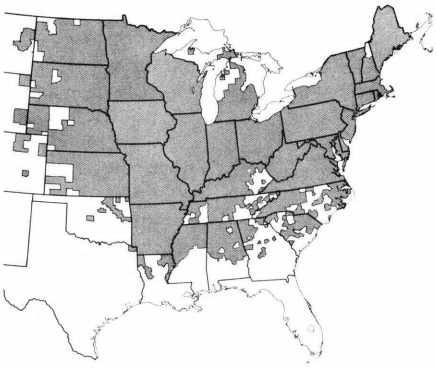

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**Figure 1.—Area in the United States known to be infested by the European corn borer in 1966.**

In May or early June the larva spins a thin cocoon, inside of which it changes to a pupa (fig. 2). If the larva is inside a tunnel in a cornstalk, it cuts a small, circular opening to the surface before pupating, to provide an exit for the future moth. When pupation occurs in midsummer, the pupa may be located in the stalk or ear or even on the leaves.

The pupa is brown and ½ to ⅝ inch long. It transforms into an adult (moth) in 10 to 14 days.

The female moth (fig. 3, *A*) has a robust body and a wingspread of about 1 inch. The color is pale yellow to light brown. The outer third of the wings is usually crossed by two dark zigzag lines.

The male moth (fig. 3, *B*) is smaller, has a more slender body, and is darker than the female. The outer third of the wings is usually crossed by two zigzag streaks of pale yellow, and often there are pale-yellow areas on the forewings.

Moths from overwintered borers emerge from May to early July; those of the summer broods emerge from July to September; the time of emergence is influenced by latitude and weather conditions. Soon after they emerge, they mate and the females lay their eggs.

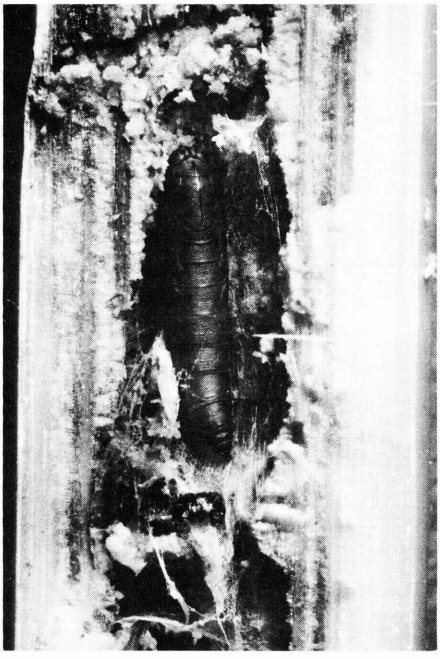

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**Figure 2.—European corn borer pupa inside cornstalk. (Enlarged.)**

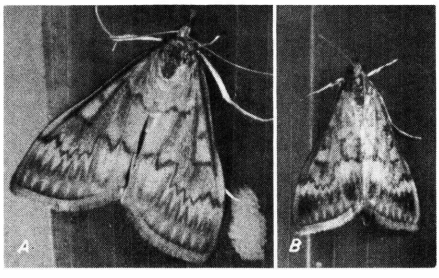


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**Figure 3.—European corn borer moths: *A*, Female, with egg mass on corn leaf; *B*, male. (Courtesy of Illinois Natural History Survey.)**

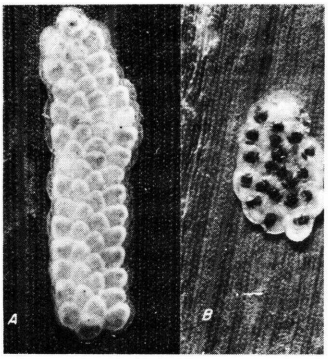


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**Figure 4.—Eggs of European corn borer: *A*, Soon after being laid; *B*, in blackhead stage about ready to hatch.**

The females hide during the day in weeds and grass or underneath the leaves of corn or other plants. In the evening and sometimes throughout the night, when weather conditions are favorable, they fly from plant to plant laying their eggs in flat, irregularly shaped masses (fig. 4, *A*).

The number of eggs laid by a female varies; the average is about 400, but as many as 1,900 have been observed. The moths usually live from 1 to 3 weeks.

Eggs of the first brood are laid from May to July, and those of the second and third broods from July to September. Usually they are laid on the under sides of corn leaves. Occasionally they are laid on the upper sides of the leaves, on the stalks, or on the husks of the ears.

There are usually 15 to 20 eggs in an egg mass; sometimes there are fewer. The eggs, each about half the size of a pinhead, overlap one another like fish scales. They are white when first laid, change to pale yellow, and become darker just before hatching (fig. 4, *B*), when the dark brown heads of the borers inside can be plainly seen.

The eggs hatch in 4 to 9 days, depending on the temperature. The newly hatched larva is about 1/16 inch long. It has a black head and a pale-yellow body that bears several rows of small black or brown spots. During its growth the borer changes its skin, or molts, five or six times, increasing in size with each change until it becomes fully grown.

## DAMAGE

European corn borer damage is caused by the larvae feeding in and on various parts of the corn plant. Where two broods of the insect occur, the larvae of the first brood cause the greater reduction in yield because of their attack on the plants in the early stages of development. Second-brood borers may be responsible for extensive stalk breakage and ear dropping, even though they may not reduce the yield seriously.

Leaf feeding that results in the destruction of the leaf surface, sheath girdling, and breakage of the midribs causes reduction in yield (fig. 5).

Stalk tunneling reduces yield by weakening the plant and starving the ear. The tunneling also exposes the plant to disease organisms that cause stalk and ear rots. Stalks thus weakened break easily, and make harvesting more difficult and expensive (fig. 6).

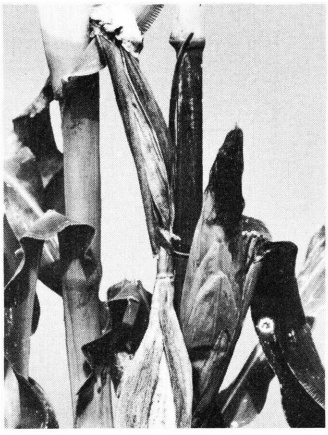

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**Figure 5.—European corn borer damage to plant. Note heavy leaf feeding and ear broken over and dried prematurely as a result of boring in shank.**

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**Figure 6.—Sweet corn severely damaged by extensive tunneling of European corn borer larvae.**

Ears are damaged by the larvae feeding on the silks, kernels, and cobs, and by their boring in the shanks (fig. 7). Shank injury may cause poor development and serious dropping of the ears before they can be harvested. In late-planted corn, or late-maturing hybrids, ears that have their shanks badly damaged by second-brood corn borers are likely to be chaffy (fig. 8). Chaffiness is also common in ears from plants that have broken over below the ear as a result of first-brood infestation. Ear damage to sweet corn is of special concern to growers of canning and market garden corn (fig. 9).

It is easy to detect corn borer injury to corn. If the infested plants are in the whorl stage, look for small holes and elongated chewed areas in the leaves; these are caused by feeding of young larvae before the leaves unfold. At time of tasseling, search for young larvae feeding in the tassel buds or tunneling in the tassel stem or its branches. This

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**Figure 7.—Stalk and ear shank cut open to show European corn borer larvae and their feeding. Boring in the shank causes ear to break off and drop to the ground.**

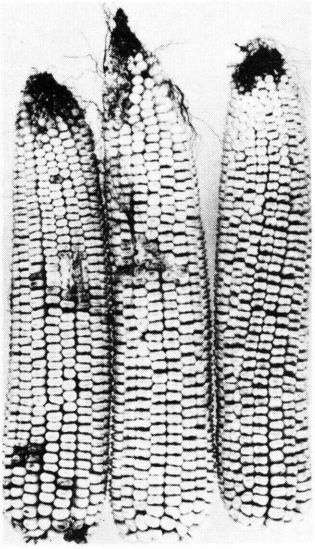

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**Figure 8.—Chaffy ears are result of European corn borer damage to shanks of late-planted corn.**

tunneling often causes the tassels to break over (fig. 10) and sawdustlike frass to appear at the breaks.

Later in the season, examine the leaf sheaths for signs of borer feeding. Examine the stalk, especially behind the sheaths, for holes and sawdustlike frass where the larvae have entered to tunnel in the stalk. Feeding by borers at the base of the leaves, often in the midribs, sometimes causes the leaves to break over at that point. If the infestation occurs after pollen shedding, many of the young larvae first feed on the accumulations of pollen on the plants. When a number of large borers tunnel extensively in the stalk, they weaken the plant so that it breaks over. Severely injured plants dry earlier than uninjured or slightly injured plants.

Young larvae usually enter the ear near the tip, feed on the silks or on the tender part of the husk, and then work their way into the cob and grain. However, larger larvae may enter the ears directly at the tip, base, or side, or they may bore into the ear shank.

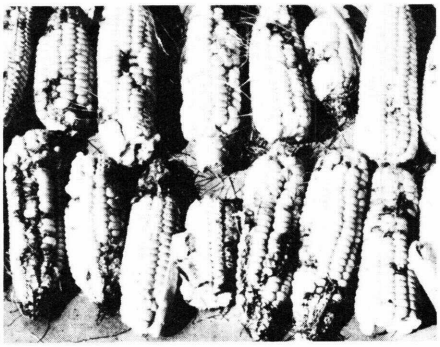

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**Figure 9.—Ears of sweet corn severely damaged by European corn borer.**

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**Figure 10.—Corn tassel broken over by European corn borer larvae.**

## CONTROL

The habits of the European corn borer, and the cultural practices employed in corn production and utilization, are different in different areas. However, the sound farming practices discussed here, and the recommended use of insecticide, work hand in hand for the achievement of effective corn borer control in any area.

### Use Resistant or Tolerant Corn Hybrids

Inbred lines with a high degree of resistance to first-brood infestation have been released by several State agricultural experiment stations, and are being used by corn breeders in the development of new and better hybrids (fig. 11). Hybrids that contain three resistant lines usually have more than 50 percent less borer survival than hybrids made up of three susceptible lines. Some hybrids are tolerant and produce good yields by withstanding the attack of the corn borer (fig. 12). A borer-tolerant hybrid stands well and holds its ears despite infestation, and therefore can be harvested efficiently with mechanical pickers.

Plant resistant or tolerant hybrids that are adapted to your locality. Consult your State agricultural experiment station or county agent for the latest recommendations.

### Destroy Borers by Tillage Practices

Plow under the old cornstalks and weeds as cleanly as possibly before the moths emerge in spring. Where soil erosion is not a problem, plow in fall. Bury the crop residue, where soil conditions permit, so that a minimum amount of it will be

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**Figure 11.—Susceptible corn on left severely damaged by European corn borer. Resistant corn on right has little damage.**

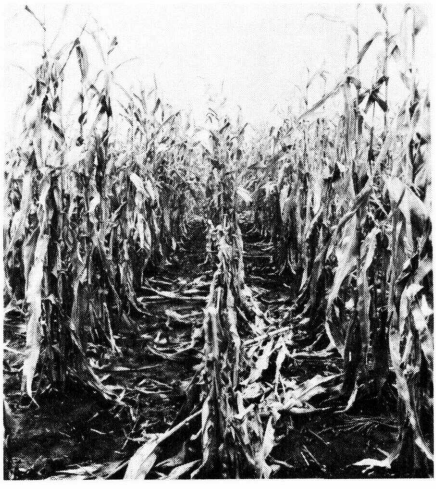

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**Figure 12.—Rows of corn on left and right tolerant to European corn borer. Center row not tolerant, and badly damaged.**

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**Figure 13.—Spring plowing as a means of European corn borer destruction.**

brought to the soil surface in seedbed preparation. In itself, plowing does not kill many borers. The insects come to the surface and burrow into plant material. If little debris is available, many borers die from exposure or are destroyed by natural enemies.

Plows now on the market are well adapted for clean plowing. When properly adjusted, plows with a rolling colter will effectively turn under cornstalks and trash. Figure 13 shows a good job of clean plowing. Disking, or chopping with a power-driven chopper is helpful in obtaining a clean job of plowing.

## Adjust Planting Dates

Plant corn at the time that, as shown by experience, produces the best results for your locality. Corn planted then is likely to give high yields.

Usually, early-planted corn is the most severely infested. Late-planted or late-maturing corn is most likely to be heavily infested by the second brood of the corn borer, suffer stalk breakage and ear dropping, and be difficult to harvest. It also probably will yield less and be higher in moisture content at harvesttime.

## Insecticidal Control on Corn

Chemical treatment alone will not solve the borer problem. All available control measures must be applied to the limit of their practical usefulness. However, insecticides are valuable tools in the control program. Properly timed insecticide treatments enable the individual grower to protect his crop. To be sure of getting an adequate supply of insecticides, plan your insecticidal control measures in advance of the season.

### *Determining need for treatment*

Need for treatment is determined by the value of the crop and the intensity of infestation. Treatment is never warranted unless it is expected that the improvement in the quantity or quality of the resulting crop will more than compensate for the increased cost. Treatment of field corn for first-brood borers usually will be profitable if 75 percent of the plants show leaf feeding in the whorl. Crops of higher values such as seed or popcorn should be treated if 25 percent of the plants show leaf feeding. Second-brood borer control on such crops will be profitable if corn shows green silks when moths in an area are flying.

### *Selecting insecticide*

Research has developed a number of insecticides that will effectively control the European corn borer. You may select a material to apply in the form of spray, granules, or dust (see guide below).

Prepare a spray by mixing an emulsifiable concentrate or wettable powder with enough water to give the proper dosage, according to the rate of output of your spray machine. For example, if the machine has an output of 3 gallons per acre, and 3 quarts of concentrate per acre are required to give control, add 3 quarts of concentrate to each 2¼ gallons of water to make 3 gallons of total spray.

New research findings make it necessary to change insecticide recommendations frequently. Before applying insecticides, consult technicians in your area who are trained in the use of these materials and who will be familiar with latest developments. Consult county agricultural agents, field representatives of seed-corn and canning companies, or technical representatives of insecticide manufacturers.

### *When to apply insecticide*

The timing of applications, especially on canning, market garden, or seed corn, is one of the most important considerations in insecticidal control of the corn borer. Anyone not familiar with the problems of timing should consult his county agricultural agent or field representative of the company for which he is growing the corn.

Apply one of the following:

| Insecticides [1] | Amount of active ingredient to be applied per acre |
|---|---|
| *Spray* | *Pounds* |
| Carbaryl (Sevin), 85-percent wettable powder | 1.5 |
| Carbaryl (Sevin), 50-percent wettable powder | 1.5 |
| DDT, 25-percent emulsifiable concentrate | 1.5 |
| EPN, 25-percent wettable powder | 0.25 |
| *Granules* | |
| Carbaryl (Sevin), 20-percent formulation | 1.5 |
| Carbaryl (Sevin), 10-percent formulation | 1.5 |
| DDT, 5-percent formulation | 1.0 |
| EPN, 1-percent formulation | 0.2 |
| *Dust* | |
| DDT, 5-percent formulation | 2.0 |

[1] Mention of a proprietary product in this publication does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture and does not imply its approval by the Department to the exclusion of other products that may also be suitable.

Restrictions:

Do not feed forage that has been treated with DDT or Toxaphene to dairy animals or to animals being finished for slaughter.

Do not apply EPN within 14 days of harvest.

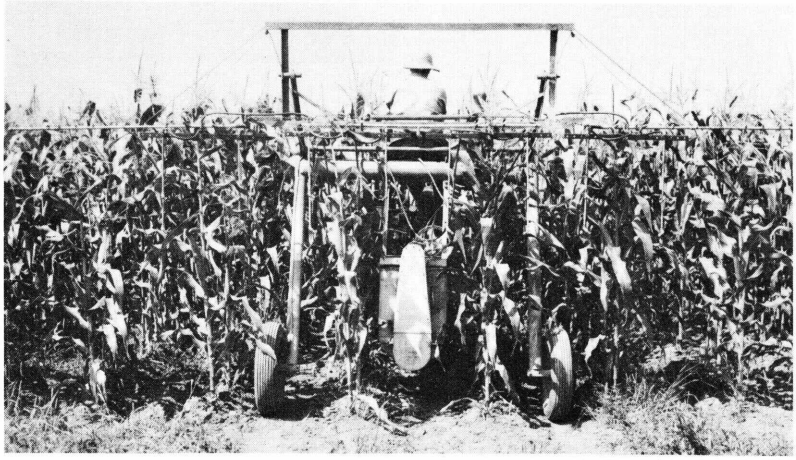

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**Figure 14.—High-clearance sprayer for European corn borer control.**

The number of first-brood treatments depends on the severity of infestation and the degree of control desired. In general, except under very heavy infestation, one treatment should suffice on field corn. Seed or other valuable crops may require two or more treatments. Treatment of plants that are less than 35 inches in extended height is warranted only in very severe infestations.

If a single treatment is used, it should be applied when 75 percent of the plants show evidence of fresh feeding in the whorl. In a two-treatment schedule, the first application should be made as stated above and the second should be made 7 days later if new leaf feeding is evident.

When there is a heavy first brood followed by a large moth flight, a treatment to control second-brood borers to prevent stalk breakage and ear dropping may be profitable. Treat as soon as egg masses average 100 to each 100 plants; or you may apply a preventive treatment to all corn that has not completed pollen shedding when the first second-generation eggs are reported in the production area.

There are various procedures for determining the time to apply insecticide for borer control. Several States provide current information on the development of the borer that is of value in timing control operations, and they suggest the use of additional timing criteria. Use this service if it is provided by your State.

### *Equipment and application*

Insecticides can be applied effectively for corn borer control with a wide range of equipment. Proper operation is essential.

*Sprayers.*—Satisfactory control can be obtained with ground sprayers (fig. 14). For first-brood control, they should be equipped with a boom that has two or three nozzles

per row adjusted to spray 10 inches above the row with pressures ranging from 40 to 50 pounds per square inch. For second-brood control, four nozzles per row should be used and the spray should be directed at the ear zone.

If airplanes are used for spraying, they should be equipped with booms that have multiple nozzles arranged to spray as evenly as possible across the swath. When making aerial applications, limit swath widths to the plane's wingspan. Have a flagman in the field to guide the pilot. Flight height should not exceed 6 feet from top of corn to wheels. Aerial applications should be made only when wind conditions would cause a minimum of drift.

*Equipment for applying granules.*—Ground equipment for the application of granules is available commercially (fig. 15). Row-crop dusters are not satisfactory for applying granules. Aerial applications of granules should be made at a height of 35 to 40 feet.

*Dusters.*—Row-crop dusters are suitable for use in corn borer control. Ground dusters that have high air velocity and volume are more satisfactory than those that have low velocity and low volume. Use two nozzles per row. Set nozzles 5 inches above the plants when applying dust to corn in the whorl stage; set them from the ear zone upward for second-generation control.

## Natural Enemies

### *Imported parasites*

As a step in control of the European corn borer in the United States, insect parasites have been imported from Europe and the Orient and released over most of the heavily infested areas. A number of the 21 kinds introduced have become established, but only 4 of them have proved of value in reducing borer populations, and the usefulness of these 4 is sometimes limited to certain areas.

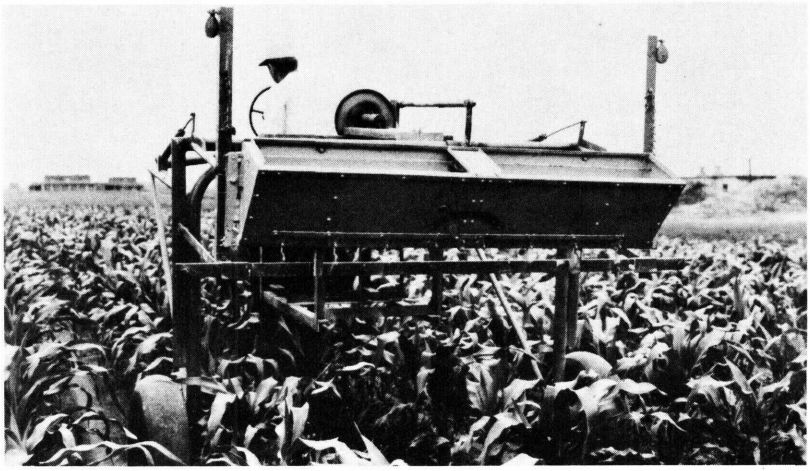

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**Figure 15.—Applying granules with ground equipment.**

## PRECAUTIONS

Insecticides used improperly can be injurious to man and animals. Use them only when needed and handle them with care. Follow the directions and heed all precautions on the labels.

Some States have special restrictions on the use of certain insecticides. Before applying insecticides, check State and local regulations.

Keep insecticides in closed, well-labeled containers in a dry place. Store them where they will not contaminate food or feed, and where children and animals cannot reach them. Promptly dispose of empty insecticide containers; do not use for any other purpose.

When handling an insecticide, wear clean, dry clothing.

Avoid repeated or prolonged contact of insecticide with your skin.

Wear protective clothing and equipment if specified on the container label. Avoid prolonged inhalation of insecticide dusts or mists.

Avoid spilling an insecticide concentrate on your skin, and keep it out of your eyes, nose, and mouth. If you spill any on your skin or clothing, remove contaminated clothing immediately and wash the skin thoroughly with soap and water. Launder the clothing before wearing it again.

After handling an insecticide, do not eat, drink, or smoke until you have washed your hands and face. Wash any exposed skin immediately after applying an insecticide.

Avoid drift of insecticide to nearby wildlife habitats, bee yards, crops, or livestock. Do not apply insecticides under conditions favoring drift from the area to be treated.

Many insecticides are highly toxic to fish and aquatic animals. Keep insecticides out of all water sources such as ponds, lakes, streams, and wells. Do not clean spraying equipment or dump excess spray material near such water.

Do not apply insecticides to plants during hours when honey bees and other pollinating insects are visiting them.

To minimize losses of honey bees and other pollinating insects, make insecticide applications, when possible, during hours when the insects are not visiting the plants. Avoid drift of insecticide sprays to nearby crops or livestock. Avoid drift of insecticides into bee yards.

Have empty insecticide containers buried at a sanitary land-fill dump, or crush and bury them at least 18 inches deep in a level, isolated place where they will not contaminate water supplies.

Carbaryl (Sevin) and DDT can be used without special protective clothing or devices, when applied at dilutions and formulations recommended.

Toxaphene can be absorbed directly through the skin in harmful quantities. When working with this insecticide in any form, take the same precautions as with concentrates.

EPN is highly toxic and may be fatal if swallowed, inhaled, or absorbed through the skin. This highly toxic insecticide should be applied only by a trained operator.

*Lydella thompsoni* Herting (fig. 16), a fly that looks much like the common house fly, is the most widely effective parasite. The females deposit live maggots near corn borer larvae. The maggots penetrate the larvae, feed internally, and thus kill them.

A very small, black wasp known as *Sympiesis viridula* (Thomson) is generally distributed from Ohio to Iowa. From 5 to 10 larvae of this parasite feed externally on a single borer. Because they are so small, they are often overlooked.

In the Eastern States, two other

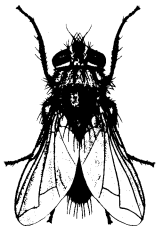

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**Figure 16.—Adult of *Lydella thompsoni* Herting an important parasite of the European corn borer.**

wasps are important parasites of the borer. *Horogenes punctorius* (Roman) is black and has reddish legs; it is about ½ inch long. Only one of these parasites develops in a single larva. The other species, *Macrocentrus gifuensis* Ashmead, is a light amber color. From 10 to 25 live within a larva, and later come to the outside of the destroyed larva to spin their cocoons. Both of these parasites are present in the Corn Belt, and *Macrocentrus gifuensis* has recently increased to appreciable numbers in parts of Iowa.

### *Other natural enemies*

Several other natural enemies of the European corn borer attack the pest in this country. A number of native insects destroy varying proportions of the borer population. Lady beetles and lacewings occasionally destroy large numbers of corn-borer egg masses and small larvae. Birds, particularly woodpeckers and blackbirds, feed on corn borer larvae in the fields.

A fungus disease, *Beauveria bassiana*, which attacks the borer, and a protozoan disease organism, *Perezia pyraustae*, are present in the United States. The former disease kills the larvae. The latter infects the eggs, larvae, pupae, and adults. *Perezia* causes the moths to lay fewer eggs than they normally do. It reduces the ability of the larvae to establish on some corn hybrids, and to survive extremes of temperature and humidity.

## LARVAE MISTAKEN FOR THE EUROPEAN CORN BORER

Several native larvae are often mistaken for the European corn borer. Some of them look much like the corn borer; others, though very different in appearance, cause similar damage to the corn.

### Corn Earworm

The corn earworm[2] (fig. 17) causes injury to the ears of corn similar to that of the European corn borer. The earworm, however, usually confines its damage to the silks and kernels, whereas the corn borer also bores into the shank and cob. The corn earworm rarely feeds in the stalks. Early in the summer it often feeds on the leaves in the whorl or on the emerging tassel of young plants.

Larvae of the corn earworm are about 1½ inches long when fully grown. They vary greatly in color, ranging from tints of green, pink, rose, yellow, and brown to almost black. When fully grown, they are nearly twice the size of corn borer larvae.

[2] *Heliothis zea* (Boddie).

## Stalk Borer

The stalk borer [3] (fig. 18) often infests corn early in the summer in some sections of the country. The larvae burrow into plants near the base, killing the buds, and they also burrow in the stalks.

Young larvae of the stalk borer can easily be distinguished from those of the European corn borer by a dark-brown or purple band around the middle of the body, and several conspicuous brown or purple stripes running lengthwise on the body. As the stalk borer approaches full growth, these bands and stripes disappear, the color becomes plain creamy white or light purple, and the markings are barely visible. The fully grown stalk borer is slightly more than an inch long.

[3] *Papaipema nebris* (Guenée).

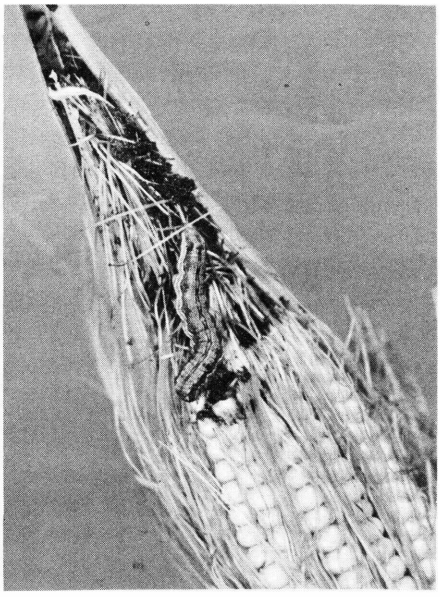

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**Figure 17.—Corn earworm feeding on silk and kernels of corn.**

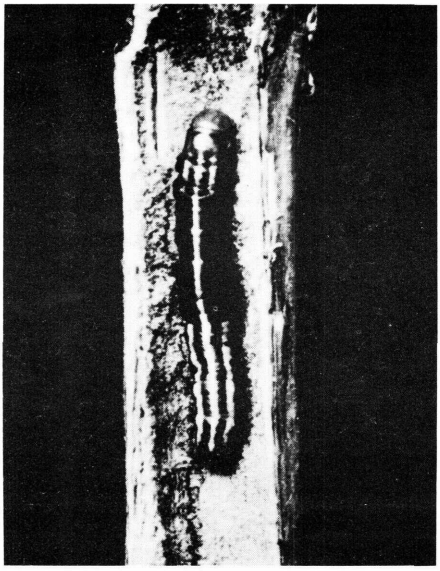

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**Figure 18.—Plant stem cut open to show stalk borer inside.**

## Armyworms

Frequently, corn is damaged by larvae of the fall armyworm.[4] These larvae feed on the leaves and in the stalk and shank, and damage the ear by feeding on the grain (fig. 19). The true armyworm [5] also attacks corn, sometimes in large numbers, and strips young plants of their leaves. The feeding of armyworms on the ear is similar to that of earworms. Armyworms are about 1½ inches long, smooth, striped, and green to brown or almost black.

## Smartweed Borer

Larvae of the smartweed borer [6] are sometimes found in corn during

[4] *Spodoptera frugiperda* (J. E. Smith).
[5] *Pseudaletia unipuncta* (Haworth).
[6] *Pyrausta ainsliei* Heinrich.

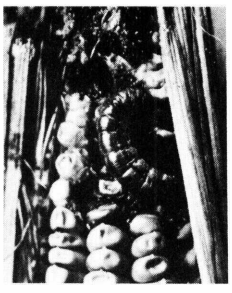
the fall, winter, and spring. This native borer resembles the European corn borer so closely in appearance and work that it is very difficult to distinguish between them. The smartweed borer usually feeds within the stems of smartweed, and causes little injury to corn.

Larvae of the smartweed borer are about 3/4 inch long when fully grown. They are slate colored and bear a very fine, faint, dark line along the middle of the back, definitely narrower and less conspicuous than this line on the European corn borer. Only under the microscope can these two kinds of borers be distinguished from each other with certainty.

## Southern Cornstalk Borer

In the South, the southern cornstalk borer [7] is a common enemy of the corn plant. It, too, has the habit of tunneling in the stalks of corn, but it does not bore into the ears. It overwinters only in the base internodes of the stalk.

[7] *Diatraea crambidoides* (Grote).



BN–15613

**Figure 19.—Fall armyworm feeding on kernels of corn near tip of ear.**

There are two forms of larvae, a summer form and a winter form. The summer form, when fully grown, is a dirty-white worm, 1 inch long, covered with many dark spots, each bearing a short, dark, bristle; it has a head and neck shield of brownish yellow. The winter form is a robust, creamy-white or yellowish, unspotted larva.

## Other Borers

Another borer, similar to the southern cornstalk borer, occurs along the gulf coast from Florida to the Mexican border. It is the sugarcane borer.[8] Although it is primarily a pest of sugarcane, it readily attacks corn. The larva may be distinguished from that of the European corn borer by its lack of stripes and dark spots.

The southwestern corn borer,[9] which also resembles the southern cornstalk borer, occurs in Arizona, New Mexico, Texas, Oklahoma, Kansas, Nebraska, Louisiana, Missouri, Arkansas, Mississippi, Alabama, and Tennessee. Its range overlaps that of the European corn borer in Oklahoma, Kansas, Mississippi, Alabama, Missouri, Louisiana, Arkansas, and Nebraska. The larvae are not striped, and the spots on the summer form are darker and more prominent than those of the European corn borer. The winter form is a uniform dirty white, and it is usually found in the lowest part of the stalk below the soil surface.

[8] *Diatraea saccharalis* (Fabricius).

[9] *Zeadiatraea grandiosella* (Dyar).



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